Draft Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area

Prepared by:

Sea Engineering, Inc.
The Louis Berger Group, Inc.

September 2012

Version: 2012/09/13

Document Control Number: NB001

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

QAPP Worksheet 1
Title and Approval Page

Site Name/Project Name: Newark Bay Study Area RI/FS Oversight (NJD980528996)
Site Location: New Jersey
Operable Unit: OU-03

Document Title: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area

Lead Organization: USEPA Region 2 _____

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Preparation Date (Day/Month/Year): September 13, 2012

Investigative Organization's
Task Leader:

_____
Jason Magalen, Sea Engineering, Inc.

Investigative Organization's
Site Quality Control Officer:

_____
AmyMarie Accardi-Dey, The Louis Berger Group, Inc._

Lead Agency's Project Manager (Approval Authority):

_____
Eugenia Naranjo, USEPA

QAPP Worksheet 2
QAPP Identifying Information

Site Name/Project Name: Newark Bay Study Area RI/FS Oversight

Site Location: Essex County, New Jersey
Site Number/Code: NJD980528996
Operable Unit: OU-03
Contractor Name: The Louis Berger Group, Inc.
Contract Number: W912DQ-11-D-3009
Contract Title: Indefinite Delivery/Indefinite Quantity Type Contract for Miscellaneous Military and Civil Hazardous Waste Cleanup Projects and Related Work
Work Assignment Number: Task Order 0006

Title: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area
Revision Number: not applicable
Revision Date:

1. Identify regulatory program:
   Comprehensive Environmental Response, Compensation, and Liability Act.
   QAPP prepared following the "Uniform Federal Policy (UFP) for Quality Assurance Project Plans" (USPEA Document No. 505-B-04-900A, Final Version 1. March 2005).

2. Identify approval entity: USEPA Region 2

3. The QAPP is (select one): ☐Generic ☒Project Specific

4. List dates of scoping sessions: refer to Worksheet 9

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
Malcolm Pirnie, Inc. 2006. "Field Sampling Plan, Volume 1." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. January 2006.	January 2006
HDR|HydroQual, Inc. 2006. "Final Modeling Work Plan." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. September 2006.	September 2006
HDR|HydroQual, Inc. 2006. "Final Modeling Work Plan Addendum." Newark Bay Study Area. Prepared for USEPA and USACE. September 2006.	September 2006
Sea Engineering, Inc. "Field Modification Form for SEDflume Consolidation Analysis." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. October 2008.	October 2008

6. List organizational partners (stakeholders) and connection with lead organization:
   - The U.S. Army Corps of Engineers (USACE), Kansas City District performs contract management for U.S. Environmental Protection Agency (USEPA) Region 2 on both the Newark Bay Study Area (NBSA) Remedial Investigation/Feasibility Study (RI/FS) Oversight and Lower Passaic River Restoration Projects. Newark Bay is an operable unit of the Diamond Alkali Superfund Site on the Lower Passaic River.
   - The Louis Berger Group, Inc. (LBG) provides consulting services under contract to USACE on the Newark Bay Study Area RI/FS Oversight Project. Battelle and HDR|HydroQual, Inc. (HDR|HQI) are team sub-consultants for The Louis Berger Group, Inc. Sea Engineering, Inc. (SEI) is a subcontractor to HDR|HQI. CDM Smith, Inc. provides consulting services for the oversight portion of the Lower Passaic River Restoration Project.
   - Tierra Solutions, Inc. (TSI) manages the RI/FS in the Newark Bay Study Area with their contractor ARCADIS. The Cooperating Parties Group (CPG) retained de maximis, inc. to manage the RI/FS on the Lower Passaic River. AECOM and Windward Environmental LLC are implementing the Lower Passaic River RI/FS under de maximis, inc.'s oversight and direction. The CPG manages the hydrodynamic and sediment transport model for both the NBSA and Lower Passaic River.

7. List data users:
   Partner Agencies [USEPA, USACE, New Jersey Department of Environmental Protection (NJDEP), U.S Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA)], LBG, Battelle, HDR|HQI, SEI, CDM Smith, CPG, TSI, and other project stakeholders.

8. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusions below: NONE.

QAPP Worksheet 3
Distribution List

Distribution List (Worksheet 3)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Addres
Eugenia Naranjo	USEPA Project Manager (Newark Bay Study Area RI/FS Oversight)	USEPA, Region 2	212-637-3467	naranjo.eugenia@epa.gov
Stephanie Vaughn	USEPA Project Manager (Lower Passaic River Restoration Project – RI/FS Oversight)	USEPA, Region 2	212-637-3914	vaughn.stephanie@epa.gov
Alice Yeh	USEPA Project Manager (Lower Passaic River Restoration Project)	USEPA, Region 2	212-637-4427	yeh.alice@epa.gov
Elizabeth Buckrucker	USACE Project Manager	USACE, Kansas City District	816-389-3581	elizabeth.a.buckrucker@us
Len Warner	Project Manager (Newark Bay Study Area RI/FS Oversight)	LBG	914-798-3721	lwarner@louisberger.com
Jason Magalen	SEDflume Task Leader (Newark Bay Study Area RI/FS Oversight and Lower Passaic River Restoration Project)	SEI	541-740-3715	jmagalen@seaengineering.
AmyMarie Accardi-Dey	Site Quality Control Officer (Newark Bay Study Area RI/FS Oversight)	LBG	914-798-3712	aaccardidey@louisberger.c
Edward Garland	Modeling Project Manager (Newark Bay Study Area RI/FS)	HDR|HQI	201-529-5151	edward.garland@hdrinc.co
James Wands	Modeling Project Manager (Lower Passaic River Restoration Project)	HDR|HQI	201-529-5151	james.wands@hdrinc.com
Frank Tsang	Project Manager (Lower Passaic River Restoration Project – RI/FS Oversight)	CDM Smith	212-377-4056	tsangc@cdmsmith.com
Field Team Members To Be Determined		Sea Engineering, Inc.		

QAPP Worksheet 4
Project Personnel Sign-Off Sheet

Project Personnel Sign-Off Sheet (Worksheet 4)

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Eugenia Naranjo	USEPA Project Manager	212-637-3467		
Len Warner	Project Manager	914-798-3721		
AmyMarie Accardi-Dey	Site Quality Control Officer	914-798-3712		
Edward Garland	Modeling Project Manager	201-529-5151		
Jason Magalen	SEDflume Task Leader	541-740-3715		

QAPP Worksheet 5
Project Organization Chart

Refer to the Project Organization Chart attached in Figure 1.

QAPP Worksheet 6
Communication Pathways

Communication Pathways (Worksheet 6)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Approval of amendments to the QAPP	LBG SEI	Site Quality Control Officer with SEDflume Task Leader approval	914-798-3712 541-740-3715	Obtain initial approval from SEDflume Task Leader. Submit documented amendments within 10 working days for transmittal to USACE and USEPA for approval.
Document control	LBG	Project Manager	914-798-3721	Project document distribution to USACE and USEPA for review and approval.
Stop work and initiation of corrective action	LBG	Project Manager	914-798-3721	The Project Manager communicates within 24 hours of stop work to the project organization by phone with confirming e-mail.
Real time modification, notifications and approval	LBG SEI	Site Quality Control Officer with SEDflume Task Leader approval	914-798-3712 541-740-3715	Real time modification to the project will require the approval of the Site Quality Control Officer and SEDflume Task Leader and will be documented using a Field Modification Form within 10 working days.
Reporting of serious issues	LBG	Project Manager SEDflume Task Leader	914-798-3721 541-740-3715	Field Team Members will report serious issues to the SEDflume Task Leader, who will communiceate them to the Project Manager. The Project Manager will report any serious issues to the USEPA and USACE and other concerned parties by phone or e-mail.
Corrective action and audit finding	LBG	Site Quality Control Officer	914-798-3712	Problems or negative audit findings are reported to the Project Manager by e-mail within 10 working days.
Field communication	SEI	SEDflume Task Leader	541-740-3715	Communicate with staff in the field to coordinate field work and collection of field samples. Summarize daily activity in electronic mail format to Project Manager.
Field communication with the USEPA and USACE	LBG SEI	Project Manager SEDflume Task Leader	914-798-3721 541-740-3715	As necessary, communicate with the USEPA and USACE on observations made during field work.
Communication with laboratories	SEI	SEDflume Task Leader	541-740-3715	Communicate with SEI (in-house laboratory) to address any analytical issues. The SEDflume Task Leader will communicate with the Site Quality Control Officer on any analytical issues that arise.

QAPP Worksheet 7
Personnel Responsibilities and Qualification Table

Personnel Responsibilities and Qualification Table (Worksheet 7)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Beth Buckrucker	USACE Project Manager	USACE, Kansas City District	USACE Project Manager	NA
Eugenia Naranjo	USEPA Project Manager	USEPA, Region 2	USEPA Project Manager	NA
Len Warner	LBG Project Manager	LBG	Investigative Organization Project Manager	BSE Engineering, 22+ years of experience in Environmental Engineering, specifically contaminated site investigation and remedial planning.
AmyMarie Accardi-Dey	Site Quality Control Officer	LBG	Site Quality Control Officer	PhD Environmental Engineering/Chemical Oceanography, 8+ years of experience in Environmental Engineering, specifically analytical chemistry and contaminated site investigation and remedial planning.
Edward Garland	Modeling Project Manager	HDR|HQI.	Review sediment transport model parameterization	ME Environmental Engineering, 30+ years of modeling experience.
Jason Magalen	SEDflume Task Leader	SEI	Conduct erosion rates study	PE, CH in Coastal/Ocean Engineering, 8+ years experience in surveying, data collection and analysis, and modeling.

Resumes and copies of certifications are on file at the LBG office in Elmsford, New York; HDR|HQI office in Mahwah, New Jersey; and SEI office in Santa Cruz, California.

QAPP Worksheet 8
Special Personnel Training Requirements Table

Special Personnel Training Requirements Table (Worksheet 8)

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
SEDflume field and analytical team and site visitors for erosion rate testing	Safety and OSHA training as specified in the Health and Safety Plan[1]	SEI HDR|HQI LBG	Training dates kept in company/project training records	All field team members working on-site	SEI SEDflume Field and Analytical Team HDR|HQI (visitor) LBG (visitor)	Training records are on file at the LBG office in Elmsford, New York; HDR|HQI office in Mahwah, New Jersey; and SEI office in Santa Cruz, California

1: The Site-Specific Health and Safety Plan (dated September 2012) will be provided to the USEPA and the USACE under separate cover.

QAPP Worksheet 9
Project Scoping Session Participants Sheet

Project Scoping Session Participants Sheet (Worksheet 9)

Project Name: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area **Projected Date(s) of Sampling**: October 2012 **Project Manager**: Eugenia Naranjo (USEPA) Elizabeth Buckrucker (USACE) Len Warner (LBG)	**Site Name**: Newark Bay Study Area RI/FS Oversight **Site Location**: New Jersey
Date of Session: 28 August 2012 Scoping Session Purpose: Discuss scoping and data quality objectives of a field program to measure erosion rates in the Newark Bay.	

Name	Title	Affiliation	Phone #	E-mail Address
Eugenia Naranjo	USEPA Project Manager	USEPA	212-637-3467	naranjo.eugenia@epa.gov
Edward Garland	Modeling Project Manager	HDR|HQI	201-529-5151	edward.garland@hdrinc.com
Jason Magalen	SEDflume Task Leader	SEI	541-740-3715	jmagalen@seaengineering.com

Comments/Decisions and Action Items:

- Established the number of cores to be collected for SEDflume analysis.
- Established the number of grab samples to be collected and slurry consolidation cores to be prepared for SEDflume analysis.
- Included the collection of deep water cores from the navigation channel in the erosion rates testing program.
- Discussed logistics for SEDflume core processing and staging (80 Lister Avenue site), water storage tanks, electrical power and water supply needs.
- Discussed anticipated project schedule.

QAPP Worksheet 10
Problem Definition

Problem Definition (Worksheet 10)

The problem to be addressed by the project:
As described in the Administrative Order on Consent (AOC) between the USEPA and the Occidental Chemical Corporation (a successor to the Diamond Alkali Company) dated February 17, 2004, remedial investigation activities for Newark Bay were determined to be necessary to characterize the areal extent of contamination associated with the Diamond Alkali Superfund Site (OU-01) located on the Lower Passaic River in Newark, New Jersey. Since the Lower Passaic River and Newark Bay are hydrologically-linked waterbodies, the RI/FS for the Newark Bay Study Area (also referred to as OU-03 of the Diamond Alkali Superfund Site) will be conducted consistently with the CERCLA and SARA components of the Lower Passaic River Restoration Project (also referred to as OU-02 of the Diamond Alkali Superfund Site). Tierra Solutions, Inc. (TSI), on behalf of Occidental Chemical Corporation, contracted ARCADIS to conduct the RI/FS in the Newark Bay Study Area. In September 2009, the USEPA issued General Notice Letters to companies considered potentially responsible for the historical releases of hazardous substances of concern to the Newark Bay Study Area, including tributaries other than the Lower Passaic River. The RI/FS effort for the lower 17.4 miles of the Passaic River is being conducted by the CPG, which represents the 73 companies that signed the AOC with the USEPA on May 8, 2007 and are considered potentially responsible for the contamination in the Lower Passaic River. The CPG has retained the consultants de maximis, inc., AECOM, and Windward Environmental LLC to support them in the RI/FS effort. The RI/FS and CPG field programs are being closely monitored by the USACE and USEPA. LBG provides consulting services under contract to USACE on the Newark Bay Study Area RI/FS Oversight Project. Battelle and HDR|HQI (and their subcontractor – SEI) are team sub-consultants for LBG.

The CPG is currently developing a hydrodynamic and sediment transport numerical model for the Lower Passaic River and Newark Bay. Model development, verification, calibration, and output are being overseen by the USACE, USEPA, and their contractors. Site-specific sediment erosion properties of Newark Bay sediments are needed to support the modeling being performed by the CPG. To date, model parameterization of erosion properties in Newark Bay has been based on erosion measurements from Lower Passaic River sediments collected in 2005; however, these erosion properties exhibited substantial, unexplained, small-scale and large-scale spatial variability, which may not be representative of Newark Bay sediments. A sediment sampling and erosion measurement project is being implemented by USEPA to evaluate sediment erosion properties and their variability in Newark Bay using replicate samples from several locations, which were selected based on particle size distributions, modeled shear stress intensities, spatial location within the Bay, geomorphological categorization (based on 2006 USACE characterization), and locations where chemicals of potential concern (COPCs) have been identified. Understanding the Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts.

The environmental questions being asked:
USEPA is implementing a sediment sampling and erosion measurement project to sediment erosion properties and their variability in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during*

consolidation to accurately describe changes in erosion behavior with time, as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.
Observations from any site reconnaissance reports: Observations from and data generated by sediment coring field work conducted by TSI in Newark Bay in 2005 and 2007 was used to inform the design of the erosion rates testing program.
A synopsis of secondary data or information from site reports: • USACE sediment erosion rate measurements (SEDFlume) from sediment cores collected in the Lower Passaic River (2005). • Contaminant concentration and physical properties data from TSI sediment coring programs in the Newark Bay Study Area in 2005 (Phase 1) and 2007 (Phase 2).
The possible classes of contaminants and the affected matrices: Not applicable to erosion rates testing.
The rationale for inclusion of chemical and nonchemical analyses: Sediment bulk properties are being measured to evaluate SEDFlume erosion rates. Each sediment core (field collected and laboratory slurry core) will be analyzed via SEDFlume to estimate erosion rate. Understanding Newark Bay sediment erosion properties and their variability will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. Sediment erosion core samples will be analyzed for the following bulk property parameters: • Bulk density • Water content • Particle size distribution using laser diffraction • Loss on ignition (LOI)
Project decision conditions ("If..., then..." statements): Decisions regarding the use of the SEDflume data and findings during model parameterization are outside of the scope of this QAPP.

QAPP Worksheet 11
Project Quality Objectives/Systematic Planning Process Statements

Project Quality Objectives /Systematic Planning Process Statements (Worksheet 11)

Who will use the data?
Partner Agencies (USEPA, USACE, NJDEP, USFWS, and NOAA), LBG, CDM Smith, Battelle, HDR|HQI, TSI, CPG, and stakeholders (as necessary).

What will the data be used for?
USEPA is implementing a sediment sampling and erosion measurement project to evaluate sediment erosion properties in Newark Bay. Small-scale variability will be evaluated by testing replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts.

What type of data is needed?
Erosion rates (calculated as a function of shear stress and depth in the sediment core) will be estimated using a Sediment Erosion and Deposition Flume (SEDFlume). (Refer to the following reference on SEDFlume methods: McNeil J, Taylor C, and Lick W, 1996, *Measurements of Erosion of Undisturbed Bottom Sediments with Depth*, J. Hydraulic Engineering, 122(6) pp. 316-324.) This flume is a long (2 m), narrow (10 cm), and thin (2.5 cm) instrument that allows water to flow across a sediment surface at a prescribed flow rate. Field sediment cores or laboratory consolidated slurry cores (approximately 60 cm in length) are introduced to the flume in a rectangular (in cross-section) core barrel. The core is loaded into the flume from beneath, with the surface sediment exposed to the water that is flowing in the flume. As sediments are eroded (via applied, near-bed grain shear stresses) from the surface, the remaining core material is raised in height by the analyst using a jack so that the sediment surface level is maintained flush with the bottom of the flume. This technique simulates the erosive forces that would act solely on the surface sediment. Erosion rates are calculated as vertical loss of sediment per unit time. Erosion rates are calculated by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval. (Sediment cores can be moved at intervals as small as 0.5 mm.)

Supplemental sediment bulk parameters will be measured on each field-collected sediment core and laboratory-prepared consolidation core. Bulk parameters include: bulk density, water content, particle grain size distribution, and LOI.

How "good" do the data need to be in order to support the environmental decision?
Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

How much data are needed? (number of samples for each analytical group, matrix, and concentration)
The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5

consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe changes in erosion behavior with time, as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.*

Where, when, and how should the data be collected/generated?
Where: Newark Bay Study Area (refer to Worksheet 18 for sampling locations)
When: October 2012
How: SEDFlume studies using field-collected sediment cores will be performed by SEI at a nearby, off-site facility (80 Lister Avenue, Newark, NJ). SEDFlume studies using laboratory-consolidated slurry cores will be performed by SEI at their Santa Cruz facility. Bulk properties of sediment samples will be analyzed by SEI at their in-house laboratory.

Who will collect and generate the data?
SEI (subcontractor to HDR|HQI) field staff will collect sediment cores and sediment samples. SEI will conduct SEDFlume studies, measure sediment bulk properties, and calculate erosion rates. Refer to Worksheet 19 for container information and refer to Worksheets 26 and 27 for shipment information.

How will the data be reported?
Data reporting will include:

- Photographs of the cores prior to analysis.
- Plots and tables of the measured sediment bulk properties (refer to Worksheet 12 for bulk density, water content, and erosion rate formulas).
- Plots and tables of the down-core measured erosion rates.
- The computed critical shear stresses of the sediment core. The critical shear stress will be computed using a linear method and a power law regression fit (refer to: Roberts, J., Jepsen, R., and Lick, W., 1998, *Effects of Particle Size and Bulk Density on the Erosion of Quartz Particles*, J. Hydraulic Engineering, 124(12) pp. 1261-1267.)

Erosion rates, critical shear stresses, and sediment bulk properties will be provided to the USEPA and USACE via a report deliverable. The analytical data will be reported according to the requirements in Worksheet 29. Non-chemical laboratory data (bulk density, water content, LOI, and particle size distribution) produced by SEI laboratories will be verified by SEI Quality Assurance Officer and Site Quality Control Officer. Data verification is described in Worksheets 34, 35, and 36.

How will the data be archived?
Analytical data and scans of field forms and notes (core logs and data sheets) will be kept in LBG, HDR|HQI, and SEI project files. Hard-copies of field forms and field notes will be maintained in SEI's offices. Electronic data will be provided to the Partner Agencies as a PDF report deliverable, which will also be uploaded to the project Sharepoint site for stakeholder accessibility. The length of time that records will be archived will be at the discretion of the USACE and USEPA.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Bulk Density
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Sensitivity	MDL defined per SEI Laboratory SOP	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Bulk Density (g/cm^3) = $\rho_b = \frac{\rho_w \rho_s}{\rho_w + (\rho_s - \rho_w)W}$ where ρ_b = bulk density, ρ_w = density of water (assume constant at 1.00 g/cm^3), ρ_s = density of solids (assume constant at 2.65 g/cm^3), and W = water content (percentage).

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Water Content
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Sensitivity	MDL defined per SEI Laboratory SOP	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Water Content (unitless) = $W = \frac{M_w - M_d}{M_w}$ where W = water content, M_w = wet weight of sample, M_d = dry weight of sample.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Particle Size
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2	Sensitivity	MDL defined per SEI Laboratory SOP (99% confidence level)	Detection limit	A
		Sensitivity	≤ QL (flush instrument with clean tap water)	Method blank	A
		Accuracy	As stipulated by manufacturer (frequency: every hour)	Laboratory Control Sample (35 micron particle)	A
		Precision	RPD ≤ 1% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 50% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S & A
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

1: Prior to conducting particle size analysis, samples shall be (1) sieved through a 2,000 µm sieve (if necessary) and (2) negatively charged clay particles will be dispersed through a sonification process.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	LOI
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM D2974 Version C	Sensitivity	MDL defined per ASTM D2974 Version C	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 440±22 degrees Celsius for minimum of 1 hour	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Organic Matter (percentage) = 100 – (C × 100)/B where C = mass of sample after combustion and B = mass of oven-dried sample (not combusted)

Method detection limit is 0.01 grams on gravimetric weight and results reported to 0.1%

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Erosion Rate
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	SEI Laboratory SOP "SEDFlume" September 2012, Revision 1.0	Accuracy/Sensitivity	Flow meter checked daily; measured flow rates ±20% of recorded flows	Flow rates	A
		Accuracy/Sensitivity	Jack movement ≥ 0.5 mm	Jack movement	
		Accuracy	10^{-4} cm/s (which represents 1 mm of erosion in approximately 15 minutes)	Critical shear stress	A
		Precision	RPD ≤ 50% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S & A
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data Review	A

1: Erosion Rate = $\Delta z/T$ where Δz = amount of sediment eroded and T = time. Erosion rates are calculated as vertical loss of sediment per unit time. Erosion rates are calculated by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval. (Sediment cores can be moved upwards into the flume at intervals as small as 0.5 mm.)

QAPP Worksheet 13
Secondary Data Criteria and Limitations Table

Secondary Data Criteria and Limitations Table (Worksheet 13)

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
2005 USACE Lower Passaic River Erosion Rates	USACE 2006. "ERDC-TR-06-7: Erodibility Study of Passaic River Sediments using USACE Sedflume." September 2006.	USACE	Erosion rate and critical shear stresses will be used in the modeling of Lower Passaic River sediment beds.	USACE 2005 dataset does not contain erosion rates and critical shear stresses for Newark Bay sediments but was reviewed for information pertinent to Newark Bay study design.
2005 and 2007 TSI Sediment Coring	TSI 2005. "Newark Bay Study Area RIWP, Sediment Sampling and Source Identification Program, Phase I." Revision 1, September 2005. TSI 2007. "Newark Bay Study Area Remedial Investigation Work Plan (RIWP), Sediment Sampling and Source Identification Program, Phase II." Revision 2, Amendment 1, November 2007.	TSI	Surface sediment chemistry concentrations and physical parameters were used to identify coring locations for SEDFlume testing.	TSI 2005 and 2007 datasets do not contain data on sediment erosion rates.

QAPP Worksheet 14
Summary of Project Tasks

Summary of Project Tasks (Worksheet 14)

Sampling Tasks:
USEPA is implementing a sediment sampling and erosion measurement project to evaluate variability of sediment erosion properties in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe sediment deposition and associated changes in erosion behavior. The erosion rates measured from intact field cores are often insufficient to constrain the model consolidation physics.*

Refer to Worksheet 17 for sampling details; Attachment 2 for Field SOPs; and Attachment 3 for Analytical SOPs.

Analysis Tasks:
SEI will conduct SEDFlume studies, measure sediment bulk properties (bulk density, water content, particle size distribution, and LOI), and calculate erosion rates. Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

Quality Control Tasks:
SEI will conduct SEDFlume studies, measure sediment bulk properties (bulk density, water content, particle size distribution, and LOI), and calculate erosion rates. Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

Secondary Data:
Refer to Worksheet 13 for Secondary Data (data source and limitation on data use).

Data Management Tasks:
Refer to Worksheet 29 for discussion of data management.

Documentation and Records:
Refer to Worksheet 11 for discussion on documentation records.

Summary of Project Tasks (Worksheet 14)

Assessment/Audit Tasks: Not applicable.
Data Review Tasks: Data verification is described in Worksheets 34, 35, and 36.

QAPP Worksheet 15 – Reference Limits and Evaluation Tables
Matrix: Sediment
Analytical Group: Bulk Sediment Parameters
Concentration Level: Low

Analyte	CAS Number	Project Action Limits[1]	Project Quantitation Limit[2]	Analytical Method		Achievable Laboratory Limit	
				MDL	Method QL	MDL	QL
Bulk Density	NA	NA	0.001 g	Per ASTM 2216-05	Per ASTM 2216-05	0.001 g (for samples weighing 10-50 grams)	0.001 g
Water Content	NA	NA	0.001 g	Per ASTM 2216-05	Per ASTM 2216-05	0.001 g (for samples weighing 10-50 grams)	0.001 g
Particle Size Distribution	NA	NA	0.04 µm	Per SEI SOP for Grain Size Measurement	Per SEI SOP for Grain Size Measurement	0.04 µm (upper detection limit of 2,000 µm)	0.04 µm
Loss on Ignition	NA	NA	0.1 %	Per ASTM D2974 Version C	Per ASTM D2974 Version C	0.1 %	0.1 %
Erosion Rate	NA	NA	$\Delta z > 0.5$ mm T > 15 seconds	Per SEI Laboratory SOP	Per SEI SOP for SEDflume Testing	$\Delta z > 0.5$ mm T > 15 seconds	$\Delta z > 0.5$ mm T > 15 seconds

NA = Not applicable

1. Project Action Limits are not applicable to bulk sediment parameters.
2. The Project Quantitation Limit is equal to the laboratory achievable QL.

QAPP Worksheet 16
Project Schedule Timeline Table

Project Schedule Timeline Table (Worksheet 16)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Submit draft QAPP to partner agencies and stakeholders for review	USEPA	09/14/12	09/14/12	Draft QAPP	09/14/12
Receive comments from partner agencies and stakeholders	Draft QAPP reviewers	10/01/12	10/01/12	Technical comments	10/01/12
Prepare and submit final QAPP to USEPA for approval	LBG, HDR|HQI, and SEI	10/01/12	10/08/12	Final QAPP	10/08/12
On-site sediment coring/sampling and SEDflume field work	SEI	10/15/2012	10/31/12	Sediment samples, core logs, and field notes	Refer to draft report
SEI laboratory analyses and consolidation core testing	SEI	11/01/2012	11/30/2012	Analytical data and core logs	Refer to draft report
Draft report preparation and submittal	SEI (SEI and LBG Site Quality Control Officer will coordinate data verication)	12/01/2012	01/18/2013	Draft Newark Bay Erosion Rates Testing Report	01/18/2013
Release of draft report to partner agencies and stakeholders for review	USEPA	TBD	TBD	Draft Newark Bay Erosion Rates Testing Report	TBD
Receive comments from partner agencies and stakeholders	Draft report reviewers	TBD	TBD	Technical comments	TBD
Final report preparation and submittal	SEI	TBD	TBD	Final Newark Bay Erosion Rates Testing Report	TBD

QAPP Worksheet 17

Sampling Design and Rationale

USEPA is implementing a sediment sampling and erosion measurement project to evaluate variability of sediment erosion properties in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe changes in erosion behavior with time as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.*

Sediment Coring Collection: Sediment cores collected in water depths that are less than 20-25 feet will be obtained using standard push-coring methods. Sediment cores collected in water depths deeper than 20-25 feet will be obtained using a pneumatic/hydraulic coring apparatus that is deployed off a vessel A-Frame. Regardless of the coring technique used, at each sampling location the coring vessel will be anchored such that two cores (and the slurry material grab samples, if applicable) can be collected from coring locations no more than 25 feet apart. Core will be collected in a 10 cm x 15 cm rectangular (in cross-section) core barrel that is up to 60 cm in length; the targeted length of each recovered core is 50-60 cm.

Sediment Grab Sample Collection: Surface sediment will consist of the top 15-30 cm of material. Surface sediment will be collected with a ponar dredge.

Sample Processing: Sediment cores and surface sediment grab samples will be collected and packaged securely. Refer to Worksheets 26 and 27 for details on sample management and sample handling. SEDFlume studies using field-collected sediment cores will be performed by SEI at a nearby, off-site facility (80 Lister Avenue, Newark, NJ). SEDFlume studies using laboratory-consolidated slurry cores will be performed by SEI at their in-house Santa Cruz laboratory.

SEDFlume Studies: SEDFlume sediment cores will be processed following SEI's SOP for SEDFlume Testing (provided in Attachment 1). The SEDFlume studies will be conducted in a structured approach to provide a higher degree of confidence in the erosion rate measurements or finer resolution in depth data. The general SEDFlume approach is provided below:

- Flow rates will be applied across the sediment interface for at least 10 minutes. At the end of a 10 minute interval, the flow rate will be increased. Each flow rate increase will result in an approximate doubling of the applied grain shear stress. If sediment erosion actively occurs within a 10 minute interval, no more than 2 cm of vertical erosion will be allowed. Note that a maximum flow rate can be specified to limit the erosion analysis to the maximum expected applied shear stresses.
- If 2 cm of erosion occurs in less than 3 minutes, the flow rate will not be increased. The shear cycle will be halted and sediments sampled for bulk properties.
- If varying sediment texture is encountered within the cores, the study will be halted and sediments sampled for bulk properties. A new shear cycle will then be restarted at a lower applied grain shear stress.

The following procedure is used to measure erosion rates at several different shear stresses using only one core. Starting at a low shear stress, the flume is run sequentially at higher shear stresses, with each succeeding shear stress being twice the previous one. Generally at least three shear stresses are run sequentially, if feasible. Each shear stress is applied until at least 1 to 3 mm but no more than 2 cm are eroded. The time interval is recorded for each run with a stopwatch. The flow rate is subsequently increased (*i.e.*, increasing the applied shear stress) until at least 3 measureable erosion rates are obtained (if feasible). This cycle is repeated until all of the sediment has eroded from the core. If after three cycles a particular shear stress shows a rate of erosion less than 10^{-4} cm/s (which is the project-specific critical shear stress), it will be dropped from the cycle; if after many cycles the erosion rates decrease significantly, a higher shear stress will be included in the cycle.

Sampling Method:

Field SOPs are provided in Attachment 1
- SEI SOP for SEDflume Testing

Selected laboratory SOPs are provided in Attachment 2
- Bulk density: ASTM 2216-05
- Water content: ASTM 2216-05
- Particle size: SEI SOP for Grain Size Measurement
- LOI: ASTM D2974 Version C

QAPP Worksheet 18
Sampling Locations and Methods/SOP Requirements Table

Sampling Locations and Methods/SOP Requirements Table (Worksheet 18)

Sampling Location/ID Number	Matrix	Depth	Analytical Group	Conc Level	Estimated Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
SF-1 SF-1C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	Cores: 60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Potentially higher contribution of Passaic and Hackensack River sediments. Contrast with Station 2 for indication of variability from shallow vs. deeper water depth. Locally higher shear stresses and potentially affected by ship traffic.
SF-2	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Likely higher contribution of Passaic and Hackensack River sediments. Station 1 will provide indication of variability from shallow vs. deeper water depth.
SF-3	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 4 and 5 for lateral variability.
SF-4 SF-4C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Stations 3 and 5 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic.
SF-5 SF-5C	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 3 and 4 for lateral variability. Evaluate downcore erosion rates and assess whether small-scale erosion rate variation exists between proximal cores.

SF-6 SF-6C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	Cores: 60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Station 7 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic.
SF-7	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Station 6 for lateral variability.
SF-8	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 9 and 10 for lateral variability. Potentially higher contribution of Kill Van Kull solids.
SF-9	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Stations 8 and 10 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic. Potentially higher contribution of Kill Van Kull solids.
SF-10	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 8 and 9 for lateral variability. Potentially higher contribution of Kill Van Kull solids.
SF-11 SF-11C	In-field Sediment Core and co-located surface sediment for laboratory consolidation slurry cores	60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Station 12 for indication of variability from shallow vs. deeper water depth.
SF-12	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Station 12 for indication of variability from shallow vs. deeper water depth.

1: Refer to Figure 2 for proposed sampling locations within the Newark Bay Study Area.
2: Exact coordinates of sampling locations will be determined prior to the field effort.
3: Refer to Worksheet 20 for number of field samples; field crew will randomly select one sampling location from the following locations SF-1C, SF-4C, SF-5C, SF-6C, or SF-11C to obtain quality control samples for the laboratory consolidated slurry cores.

QAPP Worksheet 19
Analytical SOP Requirement Table

Analytical SOP Requirements Table (Worksheet 19)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Gain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	9,000 cm^3 per sediment core	Two Core Barrel (10 cm × 15 cm × 60 cm)	No preservation. Cores must be maintained in vertical position to preserve the integrity of the surface sediment and transport/handling must be minimized prior to SEDflume testing.	28 days
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	15 gallons	Three 5-gallon buckets with lids	No preservation.	28 days

QAPP Worksheet 20
Field Quality Control Sample Summary Table

Field Quality Control Sample Summary Table (Worksheet 20)

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference	Number of Coring Locations	Number of Field Duplicates	Number of Replicates	Total Number of Samples
Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	12	0	2 replicate cores per location	24 sediment cores
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	5	1	0	6 surface sediment samples (sample mass will generate 30 consolidated slurry cores in the laboratory; 5 slurry cores per sampling locations plus field duplicate)

QAPP Worksheet 21
Project Sampling SOP Reference Table

Project Sampling SOP References Table (Worksheet 21)

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work?	Comments
SOP No. 1	SEI Standard Operating Procedure for SEDFlume Testing	SEI	SEDFlume	Yes	Attachment 1

QAPP Worksheet 22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment Calibration, Maintenance, Testing, and Inspection Table (Worksheet 22)

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
SEDFlume	Flow	SEDFlume flow meter will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel.	Refer to maintenance activity	Refer to maintenance activity	Daily and before each use	Measured flow rates ±20% of recorded flows	If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this inspection does not correct the problem, a new flow meter will be installed.	SEI	SEI Laboratory SOP for SEDFlume Testing, September 2012, Revision 1.0
SEDFlume	Jack Movement	Jack movement will be checked daily by directly measuring core movement in the SEDFlume.	Refer to maintenance activity	Refer to maintenance activity	Daily and before each use	Minimum jack movement of 0.5 mm	If jack movement is not correct, jack will be inspected. If this inspection does not correct the problem, a new jack will be installed.	SEI	SEI Laboratory SOP for SEDFlume Testing, September 2012, Revision 1.0

QAPP Worksheet 23
Analytical SOP Reference Table

Analytical SOP References Table (Worksheet 23)

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
Bulk Density	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Definitive	Bulk Density	Gravimetric	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
Water Content	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Definitive	Water Content	Gravimetric	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
Particle Size	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2	Definitive	Particle Size	Laser Diffraction	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
LOI	ASTM D2974 Version C "Standard Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"	Definitive	LOI	Loss on Ignition	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	Yes, refer to Note 1
Erosion Rates	SEI Laboratory SOP for SEDflume Testing, September 2012, Revision 1.0	Definitive	Erosion Rates	SEDFlume	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No

1: For this study, LOI will be handled as a physical parameter to provide bulk sediment characteristics. Consequently, sediment samples for LOI analysis will not be preserved and LOI values will only be verified (not validated).

QAPP Worksheet 24
Analytical Instrument Calibration Table

Analytical Instrument Calibration Table (Worksheet 24)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Gravimetric (Bulk Density and Water Content)	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS and balance tare	Daily	Balance verification ±0.0003 grams of certified standard. Balance Tare = Zero ±0.0003 grams	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)
Laser Diffraction (Particle Size)	As stipulated by manufacturer with 35 micron particle standard	Hourly	As stipulated by manufacturer	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2
Loss on Ignition (LOI)	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS and balance tare	Daily	Balance verification ±0.0003 grams of certified standard. Balance Tare = Zero ±0.0003 grams	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	ASTM D2974 Version C "Standard Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"
SEDFlume (Erosion)	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22

QAPP Worksheet 25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
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Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (Worksheet 25)

Instrument/ Equipment [1,2]	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Refer to list of instruments provided in Worksheet 24 [1,2]	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24

1. The maintenance of the analytical instruments including the testing activity, inspection activity, frequency, acceptance criteria, responsible person, and SOP reference must be documented in the Laboratory Quality Manual.
2. Spare parts and maintenance of laboratory analytical instrumentation is the responsibility of the assigned laboratory.

QAPP Worksheet 26
Sample Handling System

Sample Handling System (Worksheet 26)
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Managed by SEI
Sample Packaging (Personnel/Organization): Managed by SEI
Coordination of Shipment (Personnel/Organization): Managed by SEI
Type of Shipment/Carrier: Federal Express for overnight delivery or courier to the laboratory
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Managed by SEI
Sample Custody and Storage (Personnel/Organization): Managed by SEI
Sample Preparation (Personnel/Organization): Managed by SEI
Sample Determinative Analysis (Personnel/Organization): Managed by SEI
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): Field samples do not require preservation. Sample holding time is 28 days.
Sample Extract/Digestate Storage (Number of days from extraction/digestion): Not applicable. Field samples do not require preservation.
SAMPLE DISPOSAL
Personnel/Organization: SEI and LBG
Number of Days from Analysis: At least 3 months

Sample Handling and Custody

Sample custody procedures ensure the timely, correct, and complete analysis of each sample for all parameters requested. A sample is considered to be in someone's custody if it:

- Is in his/her possession.
- Is in his/her view, after being in his/her possession.
- Is in his/her possession and has been placed in a secured location.
- Is in a designated secure area.

Sample custody documentation provides a written record of sample collection and analysis. The sample custody procedures provide for specific identification of samples associated with an exact location and the recording of pertinent information associated with the sample, including time of sample collection and any preservation techniques. For the erosion rate testing effort, field data sheets and core logs will serve as physical evidence of sample custody, since sediment cores and grab samples will remain in SEI custody from collection to analysis.

Field Sample Handling and Custody

Field records such as core logs and field data sheets provide a means of recording information for each field activity performed at the Site and documenting sample handling and custody. Worksheet 19 lists the specific sample preservation requirements for each test method.

Field Procedures

The general responsibilities of the field team are listed below:

- The SEI field crew is personally responsible for the care and custody of the samples until they are properly dispatched. As few people as possible should handle the samples.
- The field crew is responsible for entering the proper information on the core logs and field data sheets, including all pertinent information such as sample identification number, date and time of sample collection, type of analysis, and description of sample location, while conducting the field activities.
- All samples will be labeled with the project identification, sample number, matrix, type of analysis required, and preservation requirements techniques employed, if applicable.
- The samples will be properly preserved, bagged, and packed.
- The SEDflume Task Leader will review all field activities to determine whether proper custody procedures were followed during the field work and if additional samples are required.

Field Records

The core logs and field data sheets will provide the means of recording data collection activities and field observations. Entries will be described in as much detail as possible so that persons going to the Site can reconstruct a particular situation without reliance on memory. At the beginning of each day, the date, start time, weather, and names of all sampling team members present will be entered. The names of visitors to the Site and the purpose of their visit will also be recorded. All field measurements, as well as the instrument(s), will be noted. Sample identification numbers will be assigned at the time the data are entered in the field notebook.

Sample Identification System

All samples collected from the Site must be identified with a sample label in addition to an entry on the core logs. Indelible ink will be used to complete sample labels and handwritten field records. Refer to Worksheet 27 on Sample Identification.

Sample Labels/Tags

The field team is required to complete the following information on a sample label for each sample container:

1. Site Name
2. Unique Sample Number
3. Sample Matrix
4. Parameters to be analyzed
5. Date of Collection
6. Time of Collection
7. Preservation Technique Employed (if applicable)
8. Sampler's Name

Sample Receipt

A designated sample custodian at SEI will accept custody of the samples and verify that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory. Once the samples have been accepted by the SEI laboratory, checked and logged in, they must be maintained in accordance with laboratory custody and security requirements. Laboratory personnel are responsible for the custody of samples until they are returned to the sample custodian.

When sample analyses and quality assurance checks have been completed in the laboratory, the used portion of the sample must be stored or disposed of in accordance with the protocols specified in the laboratory SOW or the subcontract agreement. Identifying labels, data sheets, core logs, and laboratory records will be retained for the recordkeeping duration specified in the USACE contract and task order.

QAPP Worksheet 27
Sample Custody Requirements

Sample Custody Requirements (Worksheet 27)
Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Sample collection: Refer to Worksheet 17 on sample design rationale; refer to Field SOPs provided in Attachment 2 Packaging: Refer to Worksheet 19 for sample container and preservation Shipment and delivery to laboratory: SEI will be responsible for delivering sediment cores to the off-site processing facility (location to be determined) and shipping surface sediment samples to the SEI Santa Cruz laboratory.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): SEI laboratory will have a sample custodian, who accepts custody of the samples and verifies that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory.
Sample Identification Procedures: In the field, sediment cores and surface sediment samples will be logged using the location identification numbers noted on Worksheet 18. Unique sample identification numbers will be provided by SEI during the SEDFlume study. For example, SF1C-1 will denote consolidated slurry core collected at location "1C" after 1 day of consolidation.

Chain of Custody Procedure

Field records (core logs and field data sheets) prepared by SEI will serve as documentation of the collection and custody of the sediment cores, grab samples, and bulk property samples, since sample collection and analysis will remain completely internal to SEI.

Shipment

Grab samples to be used to prepare consolidation cores will be shipped from Newark, NJ to the SEI laboratory in Santa Cruz, CA. If the samples are sent by common carrier or air freight, proper documentation must be maintained. For example, the bill of lading or airbill must be retained by the SEDflume Task Leader.

Laboratory Custody Procedures

The laboratory custody procedures will include the following procedures:

- A designated sample custodian will accept custody of the samples and verify that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory.
- Once the samples have been accepted by the laboratory, checked and logged in, they must be maintained in accordance with laboratory custody and security requirements.
- Laboratory personnel are responsible for the custody of samples until they are returned to the sample custodian.
- When sample analyses and quality assurance checks have been completed in the laboratory, the used portion of the sample must be stored or disposed of in accordance with the protocols specified in the laboratory SOP or the subcontract agreement. Identifying labels, data sheets, COCs, and laboratory records will be retained for the recordkeeping duration specified in the USACE contract and task order.

Final Evidence Files

Core logs, field data sheets, sample preparation and analysis logbooks, and data packages will become part of the laboratory final evidence file. Other relevant documentation including records, reports, and correspondence, logs, pictures, and data review reports will be archived by SEI.

Sample Holding Times

Information on sample holding times and required preservation for each test method are provided in Worksheet 19.

Sample Packaging and Shipping Requirements

Custody of samples will be documented by SEI through the shipment of samples to their laboratory in Santa Cruz, CA by retaining airbills or bills of lading, for example, and by verifying sample label information upon receipt at their laboratory.

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Bulk Density	**Sampler's Name**	Field crew
Concentration Level	Low	**Field Sampling Organization**	SEI
Sampling SOP	Refer to Worksheet 21	**Analytical Organization**	SEI
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	**No. of Sample Locations**	Refer to Worksheet 18

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP
Balance Tare	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams
Laboratory Control Sample	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard
Constant Dry Mass	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours

Laboratory replicate	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Water Content	**Sampler's Name**	Field crew
Concentration Level	Low	**Field Sampling Organization**	SEI
Sampling SOP	Refer to Worksheet 21	**Analytical Organization**	SEI
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	**No. of Sample Locations**	Refer to Worksheet 18

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP
Balance Tare	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams
Laboratory Control Sample	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard
Constant Dry Mass	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours

Laboratory replicate	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Particle Size		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP (99% confidence level)
Method blank	Per sample	SEI laboratory SOP	Repeat instrument flush with tap water; if problem continues, notify SEDflume Task Leader and consult instrument manual	SEI (Jason Magalen or designee)	Sensitivity	≤ QL (flush instrument with clean tap water)
Laboratory Control Sample (35 micron particle)	Every hour	SEI laboratory SOP	Repeat analysis of LCS; if problem continues, notify SEDflume Task Leader and consult instrument manual. Reanalyze impacted field samples.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer
Laboratory replicate	Per sample	SEI Laboratory SOP	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 1% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	SEI Laboratory SOP	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 50% for consolidated slurry cores

Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	LOI	**Sampler's Name**	Field crew
Concentration Level	Low	**Field Sampling Organization**	SEI
Sampling SOP	Refer to Worksheet 21	**Analytical Organization**	SEI
Analytical Method/ SOP Reference		**No. of Sample Locations**	Refer to Worksheet 18

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Detection limit	As defined in ASTM D2974 Version C	As defined in ASTM D2974 Version C	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per ASTM D2974 Version C
Balance Tare	Daily before use	As defined in ASTM D2974 Version C	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams (checked daily)
Laboratory Control Sample	Daily before use	As defined in ASTM D2974 Version C	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)
Constant Dry Mass	Per sample	As defined in ASTM D2974 Version C	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 440±22 degrees Celsius for minimum of 1 hour

Laboratory replicate	Per sample	As defined in ASTM D2974 Version C	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	As defined in ASTM D2974 Version C	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	As defined in ASTM D2974 Version C	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Erosion Rates	**Sampler's Name**	Field crew
Concentration Level	Low	**Field Sampling Organization**	SEI
Sampling SOP	Refer to Worksheet 21	**Analytical Organization**	SEI
Analytical Method/ SOP Reference	SEI Laboratory SOP "SEDFlume" September 2012, Revision 1.0	**No. of Sample Locations**	Refer to Worksheet 18

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Flow rates	Daily before use	SEI laboratory SOP; Refer to Worksheet 22	If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this inspection does not correct the problem, a new flow meter will be installed. Refer to Worksheet 22.	SEI (Jason Magalen or designee)	Accuracy/Sensitivity	Flow meter checked daily; measured flow rates ±20% of recorded flows
Jack movement	Daily before use	SEI laboratory SOP; Refer to Worksheet 22	If jack movement is not correct, jack will be inspected. If this inspection does not correct the problem, a new jack will be installed.	SEI (Jason Magalen or designee)	Accuracy/Sensitivity	Jack movement ≥ 0.5 mm
Critical shear stress	Per sample	SEI laboratory SOP	Notify SEDflume Task Leader and assess data impacts	SEI (Jason Magalen or designee)	Accuracy	10^{-4} cm/s (which represents 1 mm of erosion in approximately 15 minutes)
Field duplicate	1 per sampling event	SEI Laboratory SOP	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 50% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 29
Project Documents and Records Table

Project Documents and Records Table (Worksheet 29)

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field notes and photographs	Field notes and photographs	Electronic copies of field notes will be made and stored in the project files	Not applicable	None
Shipping records	Air bills (or bills of lading)	Electronic copies of air bills will be kept in project files	Project Records	None
Analytical and sample data packages	Core logs and field data sheets	Instrument calibration records and laboratory data will be stored in electronic or hardcopy format.	Laboratory quality assurance checklist	None
Data verification reports for laboratory data	Core logs and field data sheets	Submitted to the USEPA and stored in project electronic files directory	Quality assurance checklists	None
Final Report	Not applicable	Submitted to the USEPA and stored in project electronic file directory	Quality assurance checklists	None

Project Document Control System

Project documents will be controlled by LBG Project Manager, who will maintain and distribute hardcopies and electronic copies of the project documents and any amendments. Electronic copies of project information will be maintained in the project electronic file directory and the project database.

Data Recording

Data for this project will be collected by entries onto core logs and field data sheets. Electronic copies of these records will be created and saved in the project directory. Computer-generated data associated with laboratory analyses will be generated by the SEI laboratory.

Data Quality Assurance Checks

The SEDflume Task Leader will monitor the progress of sample collection to verify that samples are collected as planned. The progress of sample collection and processing will be monitored through documentation of the samples collected each day. The laboratory will have a formal in-house Quality Assurance Plan to which it adheres and implements as part of daily operations. Data generation processes will be reviewed and modified to meet objectives, if necessary. A formalized data generation procedure will be utilized. Each analyst must have previously demonstrated, through the laboratory quality assurance program, their requisite skills.

Laboratory Data Transmittal

Laboratory data are managed by the laboratory's internal management system, beginning with sample check-in. Laboratory data reports will be provided as an attachment to the Newark Bay Erosion Rate Testing report.

Data Storage and Retrieval

Electronic copies of field notes, photographs, core logs and field data sheets will be saved and archived in the project directory. The full laboratory data reports submitted to LBG will be stored in the custody of the Site Quality Control Officer. Raw data and electronic media of all field samples, including quality control samples and blanks, will be archived from the date of generation and will be kept by the laboratory. Hard copies of project files will be archived at SEI offices and retained until the end of the contract; project closeout will be conducted in accordance with USEPA Close-out Guidelines. Data will be transferred to the USACE and USEPA upon completion of the project. Retrieval of data by others will be at the discretion of the USACE and the USEPA. The length of time that records will be archived will be at the discretion of the USACE and USEPA.

QAPP Worksheet 30
Analytical Services Table

Analytical Services Table

Matrix	Analytical Group	Conc Level	Sample Location/ ID Numbers	Analytical SOP [1]	Data Package Turnaround Time[2]	Laboratory (Name and Address, Contact Person, and Telephone Number)	Backup Laboratory/
In-field Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Refer to Worksheet 18	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SOP for SEDflume Testing	60 days (analytical) 30 days (verification)	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	A back-up laboratory has not been assigned at this time.
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Refer to Worksheet 18	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SOP for SEDflume Testing	60 days (analytical) 30 days (verification)	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	A back-up laboratory has not been assigned at this time.

QAPP Worksheet 31
Planned Project Assessments Table

Planned Project Assessments Table (Worksheet 31)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Quality control reports of any non-conformance	Daily as required	Internal	SEI	Field Crew	SEDflume Task Leader (LBG Project Manager will be notified)	SEDflume Task Leader	SEDflume Task Leader
Field Health and Safety Audit	Within the first two weeks of work	Internal	SEI	SEI Field Leader	SEDflume Task Leader (LBG Project Manager will be notified)	SEDflume Task Leader	SEDflume Task Leader

QAPP Worksheet 32
Assessment Findings and Corrective Action Responses

Assessment Findings and Corrective Action Responses (Worksheet 32)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Non-Conformance	See below	LBG Project Manager and USEPA	As soon as possible	Complete non-conformance form	SEI Field Team Leader and Field Crew	As soon as possible

Non-Conformance/QC Reporting

A non-conformance is defined as an identified or suspected deficiency or discrepancy with regard to an approved document (*e.g.,* improper sampling procedures, improper instrument calibration, calculation, computer program); or an item where the quality of the end product itself or subsequent activities using the document or item would be affected by the deficiency; or an activity that is not conducted in accordance with the established plans or procedures.

Any staff member engaged in project work that discovers or suspects a non-conformance is responsible for initiating a non-conformance report to the SEDflume Task Leader, Site Quality Control Officer or designee. The Site Quality Control Officer will evaluate each non-conformance report, and the Site Quality Control Officer will provide a disposition which describes the actions to be taken.

The Project Manager will verify that no further project work dependent on the nonconforming item or activity is performed until approval is obtained and the non-conformance is properly addressed. If the non-conformance is related to material, the Project Manager shall be responsible for making or identifying, with the non-conformance report number, the nonconforming item (if practical) and indicating that it is nonconforming and is not to be used. A copy of each non-conformance report will be included in the project file. Copies of all non-conformances shall be maintained by the Site Quality Control Officer or designee.

Field Corrective Actions

At the end of each sampling day, the field team is to report any problems requiring corrective action that were encountered during the day. Corrective action will be undertaken when a non-conforming condition is identified. A non-conforming condition occurs when QA objectives for precision, accuracy, completeness, representativeness, or comparability are not met, or when procedural practices or other conditions are not acceptable. A report is to be filed that documents the problems encountered and the corrective action implemented. A Stop-Work Order may be issued by the Site Quality Control Officer or designee, following notification to the Project Manager, if corrective action does not adequately address a problem, or if no resolution can be reached.

Internal Laboratory Audits

As part of its quality assurance program, the Laboratory Quality Assurance Manager will conduct periodic checks and audits of the analytical systems to ensure that the systems are working properly and personnel are adhering to established procedures and documenting the required information. These checks and audits will also assist in determining or detecting where problems are occurring. In addition to conducting internal reviews and audits, as part of its established quality assurance program, the laboratory is required to take part in regularly scheduled performance evaluation and laboratory audits from state and federal agencies for applicable tests. Each laboratory selected to support this program must maintain current state or federal certifications, as appropriate.

Laboratory Corrective Actions

If a particular laboratory analysis is deemed "out of control," corrective action will be taken by the laboratory to maintain continued data quality, with adherence to their corrective action policy. The coordinator of the laboratory's analytical section will be responsible for initiating laboratory corrective action when necessary.

QAPP Worksheet 33
QA Management Reports Table

QA Management Reports Table				
Type of Report	**Frequency (daily, weekly monthly, quarterly, annually, etc.)**	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)**	**Report Recipient(s) (Title and Organizational Affiliation)**
Field Health and Safety Audit	Within the first two weeks of field work	Month after field work begins	Health and Safety Manager or designee	USEPA and USACE
Data Verification Report	After laboratory data are received	Within 30 days after receiving data	Site Quality Control Officer or designee	USEPA and USACE
Corrective Action Reports	When corrective action is required	When corrective action is implemented	Project Manager	USEPA and USACE

The USACE and USEPA will receive several types of management reports. These reports will include the results of any corrective action reports and data verification reports. Problems or issues that arise between regular reporting periods may be identified to program management at any time. Information included in these reports will include the following:

- Results of Field Health and Safety Audit conducted during the period.
- An assessment of any problems with the measurement data, including accuracy, precision, completeness, representativeness, and comparability.
- A listing of the non-conformance reports including Stop-Work Orders issued during the period, related corrective actions undertaken, and an assessment of the results of these actions.
- Identification of significant quality assurance problems and recommended solutions, as necessary.

QAPP Worksheet 34
Verification (Step I) Process Table

Verification (Step I) Process Table (Worksheet 34)			
Verification Input	**Description**	**Internal/ External**	**Responsible for Verification (Name, Organization)**
Field Notes	Review the field notes for errors or omissions. This information is transmitted to the SEDflume Task Leader or designee for correction.	Internal	SEI Field Leader
Final Report	Final report will be reviewed; Quality control checklist will be signed and submitted to the USACE and USEPA.	Internal	SEI
Laboratory data packages	Laboratory data reports will be verified by the laboratory for completeness and technical accuracy prior to release.	External	SEI
	Laboratory data will be assessed using the verification procedures described in Worksheets 35 and 36.	External	SEI and LBG Site Quality Control Officer

QAPP Worksheet 35
Validation (Steps IIa and IIb) Process Table

Validation (Steps IIa and IIb) Process Table (Worksheet 35)			
Step IIa/IIb	**Validation Input**	**Description**	**Responsible for Validation**
IIa	Field Notes and photographs	Record field activities and collection of samples. Record implementation of QAPP.	SEI
IIa	Core logs and field data sheets	Examine traceability of data from sample collection to generation of project report.	SEI
IIa	Laboratory data reports	Verify the required deliverables, analyte list, analytical procedures, and project quantitation limits.	SEI
IIa	Data verification reports	Verify that data quality and usability was adequately communicated to the data users.	LBG Site Quality Control Officer
IIb	Laboratory data reports and validation guidance	Data verification according to Worksheets 36 and 37	LBG Site Quality Control Officer
IIb	Deviations from SOP and project documents.	Determine impacts of any deviation from method and the project plan.	Project Team

QAPP Worksheet 36
Validation (Steps IIa and IIb) Summary Table

Validation (Steps IIa and IIb) Summary Table					
Step IIa/IIb	**Matrix**	**Analytical Group**	**Concentration Level**	**Validation Criteria**	**Data Validator (title and organizational affiliation)**
IIa/IIb	Sediment	Bulk Sediment Parameters	Low	Verification based on Worksheet 12, 15, 24, 28 in QAPP and method SOPs; independent check on calculation for 25% of the samples	LBG Site Quality Control Officer
IIa/IIb	Sediment	Erosion Rate Calculations	Low	Verification based on Worksheet 12, 15, 24, 28 in QAPP and method SOPs; independent check on calculation for 25% of the samples	LBG Site Quality Control Officer

Subcontractor Laboratory Data
The subcontractor laboratory data will be verified by LBG Site Quality Control Officer against the QAPP and method criteria. The data verifier will also conduct a review of 25% of the samples for each analytical parameter. This means that the data verifier will review the raw data and log book sheets, and will recalculate sample and QC sample results. Once data verification is completed, a data verification report will be generated. The report will contain information regarding the parameters that are qualified, the reason for the qualification, and the direction of the bias (only for parameters qualified as estimated), when possible.

QAPP Worksheet 37
Usability Assessment

Usability Assessment (Worksheet 37)
Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Refer to Worksheet 36 for data verification.
Describe the evaluative procedures used to assess overall measurement error associated with the project: As part of the data verification process, the data verifier identifies any qualifications, the bias, if known, of the data, applies comments on the usability of the data. Any QA/QC problems with the verification will be discussed with the laboratories.
Identify the personnel responsible for performing the usability assessment: The usability of the data is the responsibility of the project team. The Project Manager will assign technical staff to perform the split sample comparison after the data has been validated and reviewed.